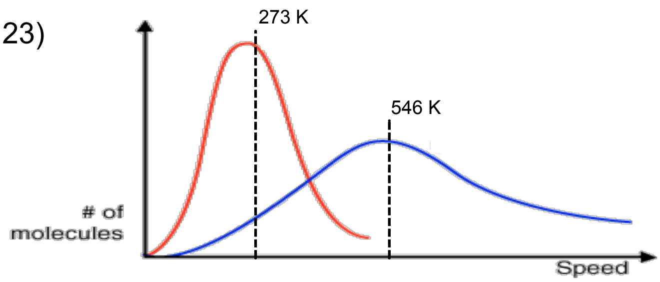
# Questions 23, 77 – 83 odd, 86, 88, 110

23)




No, the molecules have a wide range of velocities similar to the distribution chart. The temperature is just the average.

77) $KE_{avg} = {}^3/_2\,RT = {}^3/_2(8.31)\,273 = 3{,}402$ J/mol

$$\frac{3{,}402\text{ J}}{1\text{ mol}} \left| \frac{1\text{ mol}}{6.022 \times 10^{23}\text{ particles}} \right. = \textbf{\textit{5.65 x 10}}^{-21}\textbf{\textit{ J/particle (at 273K)}}$$

$KE_{avg} = {}^3/_2\,RT = {}^3/_2(8.31)\,546 = 6{,}804$ J/mol

$$\frac{6{,}802\text{ J}}{1\text{ mol}} \left| \frac{1\text{ mol}}{6.022 \times 10^{23}\text{ particles}} \right. = \textbf{\textit{1.13 x 10}}^{-20}\textbf{\textit{ J/particle (at 546K)}}$$

79) $\mathbf{KE = {}^1/_2 mv^2}$ ⟵ *Mass must be in kg*

$3{,}402 = 0.5\,(0.02802)\,v^2$
$v^2 = 2.43 \times 10^5$
***v = 493 m/s for $N_2$***

$3{,}402 = 0.5\,(0.016042)\,v^2$
$v^2 = 4.24 \times 10^5$
***v = 651 m/s for $CH_4$***

$6{,}804 = 0.5\,(0.02802)\,v^2$
$v^2 = 4.86 \times 10^5$
***v = 697 m/s for $N_2$***

$6{,}804 = 0.5\,(0.016042)\,v^2$
$v^2 = 8.48 \times 10^5$
***v = 921 m/s for $CH_4$***

81) a. they will all increase with an increase in temp
b. they will all decrease with a decrease in temp
c. avg kinetic energy and velocity will remain the same, but the frequency of collisions will increase.
d. avg kinetic energy and avg velocity stays the same, frequency of collisions increases.

83) a. They will all have the same avg. kinetic energy (same temps)
b. Flask C will have the greatest average velocity because the particles have the least mass, but the same kinetic energy.

86) $$\frac{\text{rate of effusion gas 1}}{\text{rate of effusion gas 2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

$$\frac{24.0 \text{ mL/min}}{47.8 \text{ mL/min}} = \frac{\sqrt{16.042}}{\sqrt{M_1}}$$ ***$M_1$ = 63.6 g/mol***

88) $$\frac{\text{rate of effusion } Cl_2}{0.222 \text{ L/min}} = \frac{\sqrt{4.01}}{\sqrt{70.90}}$$ rate of effusion $Cl_2$ = 0.0528 L/min = 19 min/L

110)

$$\frac{0.0335\text{g } CO_2 \mid 12.01 \text{ g C}}{\mid 44.01\text{g } CO_2} = \frac{0.009142 \text{ g C} \mid 1 \text{ mol C}}{\mid 12.01\text{g C}} = \frac{0.0007612 \text{ mol C}}{0.0007612} = 1$$

$$\frac{0.0411\text{g } H_2O \mid 2.016\text{g H}}{\mid 18.016\text{g } H_2O} = \frac{0.004599 \text{ g H} \mid 1 \text{ mol H}}{\mid 1.008\text{g H}} = \frac{0.004563 \text{ mol H}}{0.0007612} = 6$$

subtract masses to get → $$\frac{0.02126 \text{ g N} \mid 1 \text{ mol N}}{\mid 14.01 \text{ g N}} = \frac{0.001517 \text{ mol N}}{0.0007612} = 2$$

***empirical = $CH_6N_2$***

$$\frac{26.4 \text{ mL/min}}{24.6 \text{ mL/min}} = \frac{\sqrt{M}}{\sqrt{39.95 \text{ g/mol}}}$$ ***M = 46.01 g/mol***

The empirical formula mass is 46.08g/mol, so ***the molecular formula is $CH_6N_2$***